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(71) Applicant
Ayford Security Research and Development Limited

(Incorporated in United Kingdom)

Yorkhill Quay, Glasgow G3 8QV

(72) Inventor
Alan Mackintosh

(74) Agent and/or Address for Service
Murgitroyd and Company,
Mitchell House, 333 Bath Street, Glasgow G2 4ER

(54) Intruder alarm system

(57) The alarm system comprises a series of differently activated sensor devices 21,22 linked to a central controller 23. The central controller activates an alarm circuit only when the signals received from the sensors correspond to a pattern pre-determined as being consistent with the presence of an intruder. Thus spurious activations of single sensors will not activate the alarm thus lessening the likelihood of false alarms.

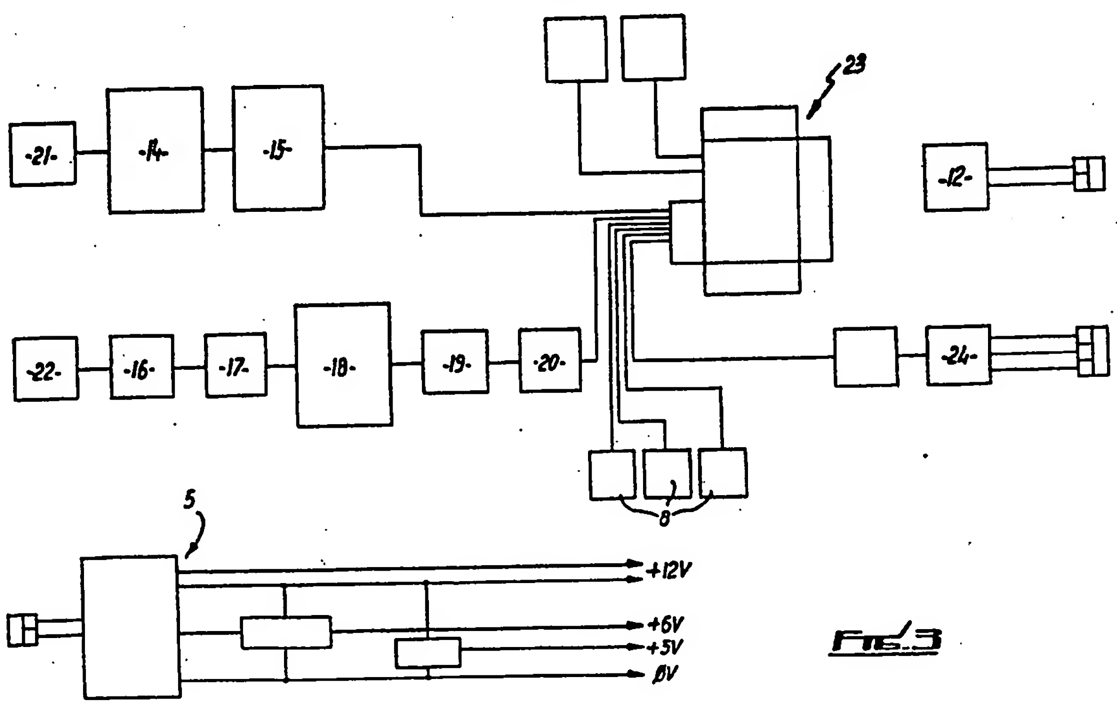

FIG. 3

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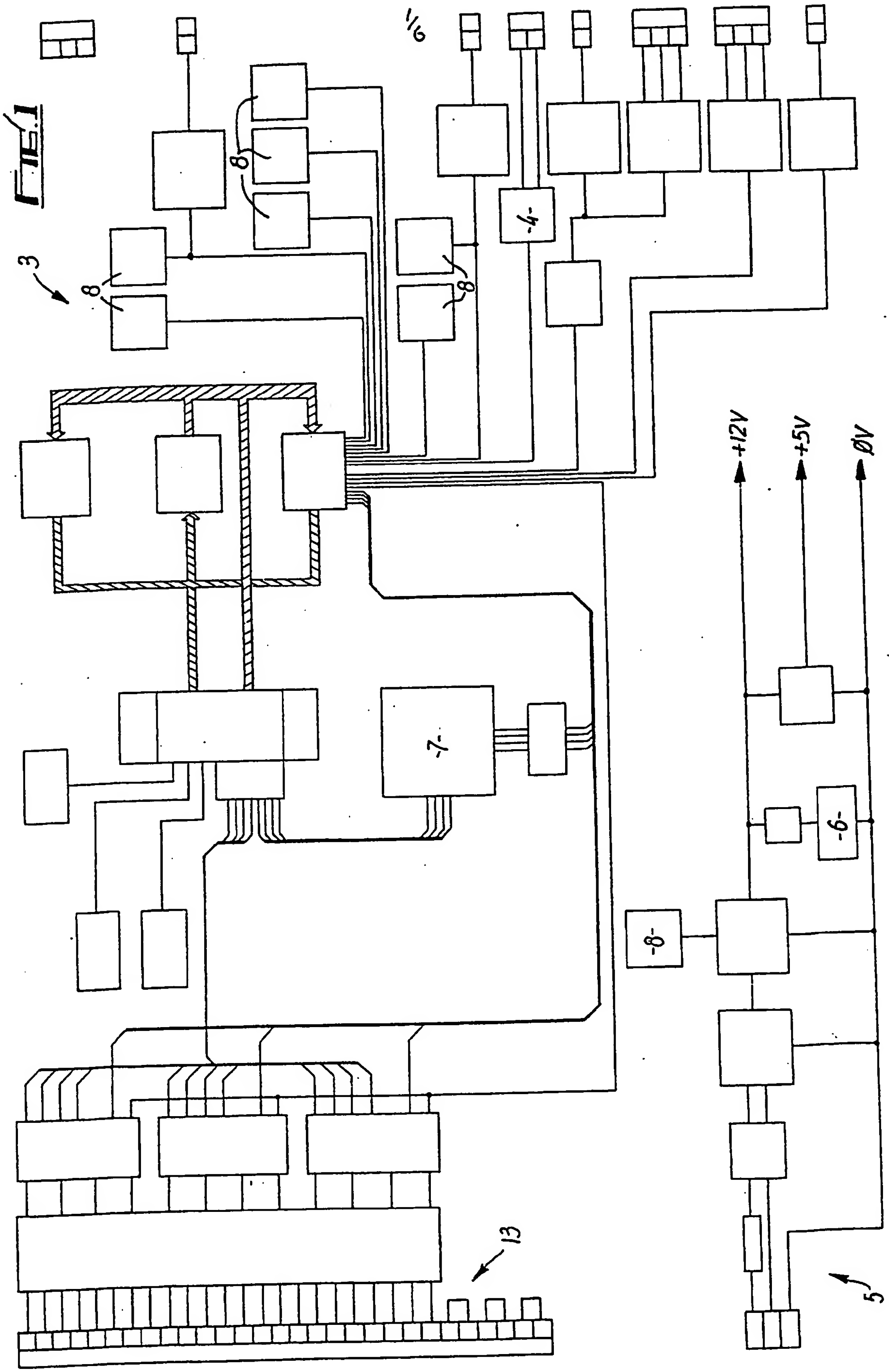

FIG. 1

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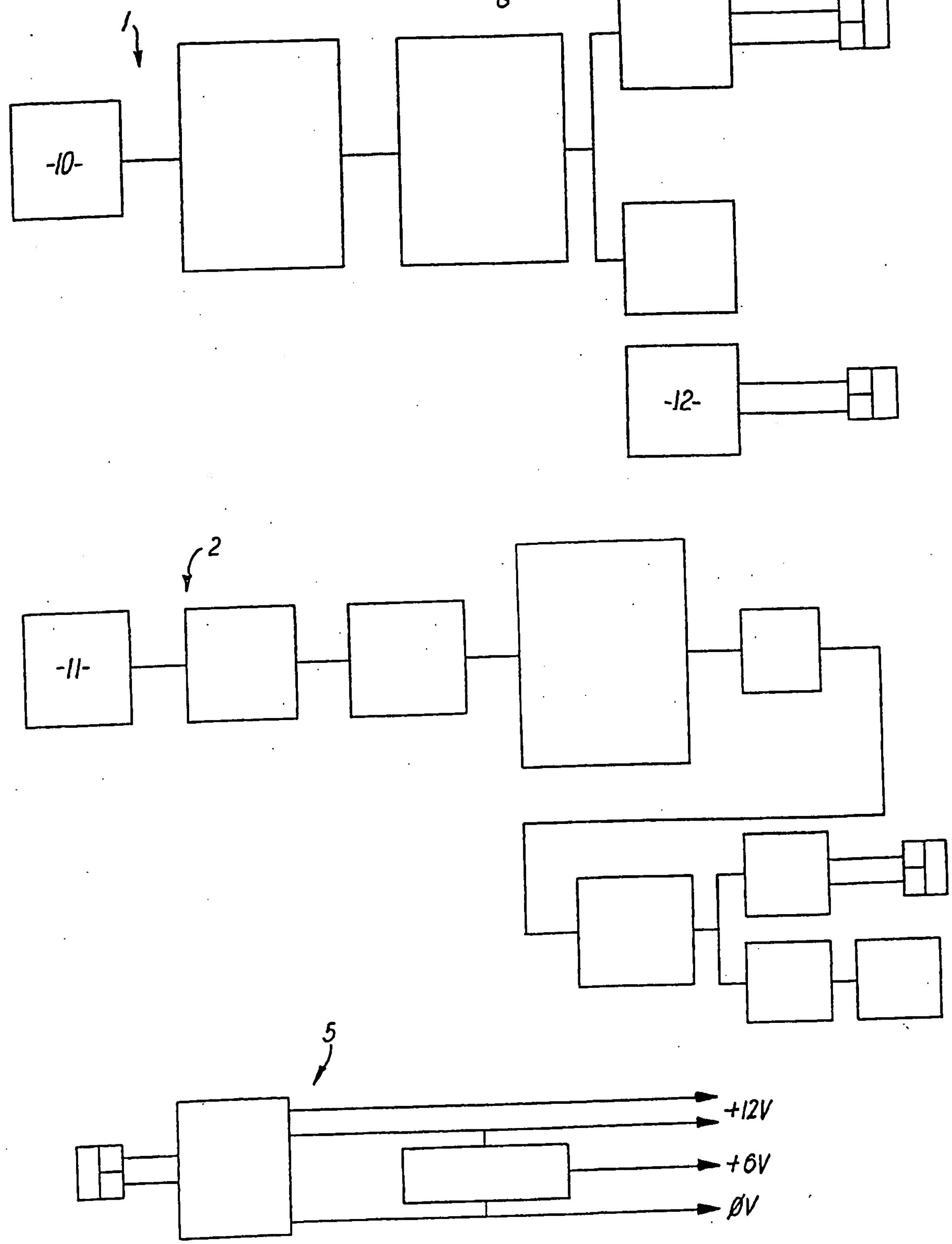

FIG.2

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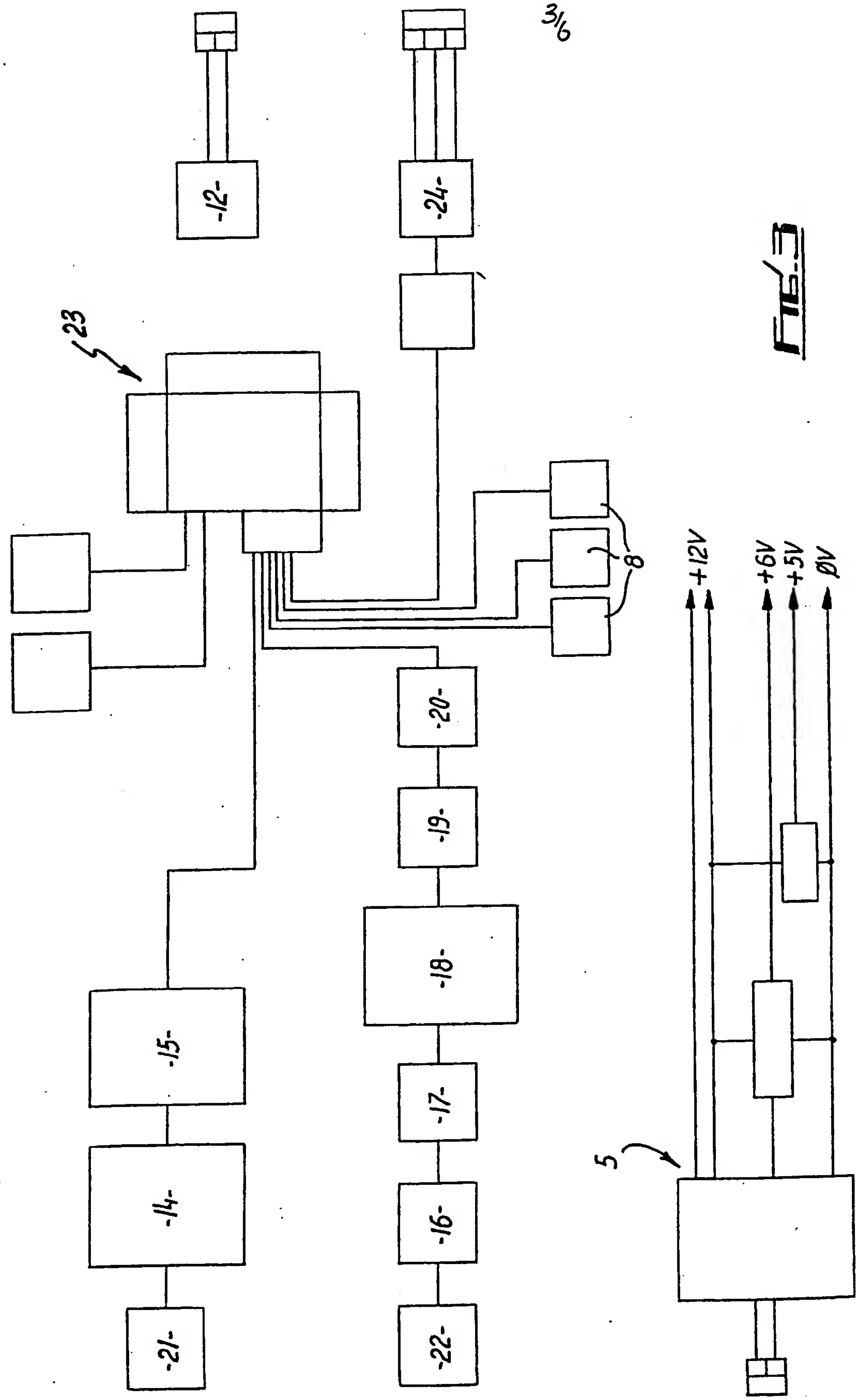

FIG.3

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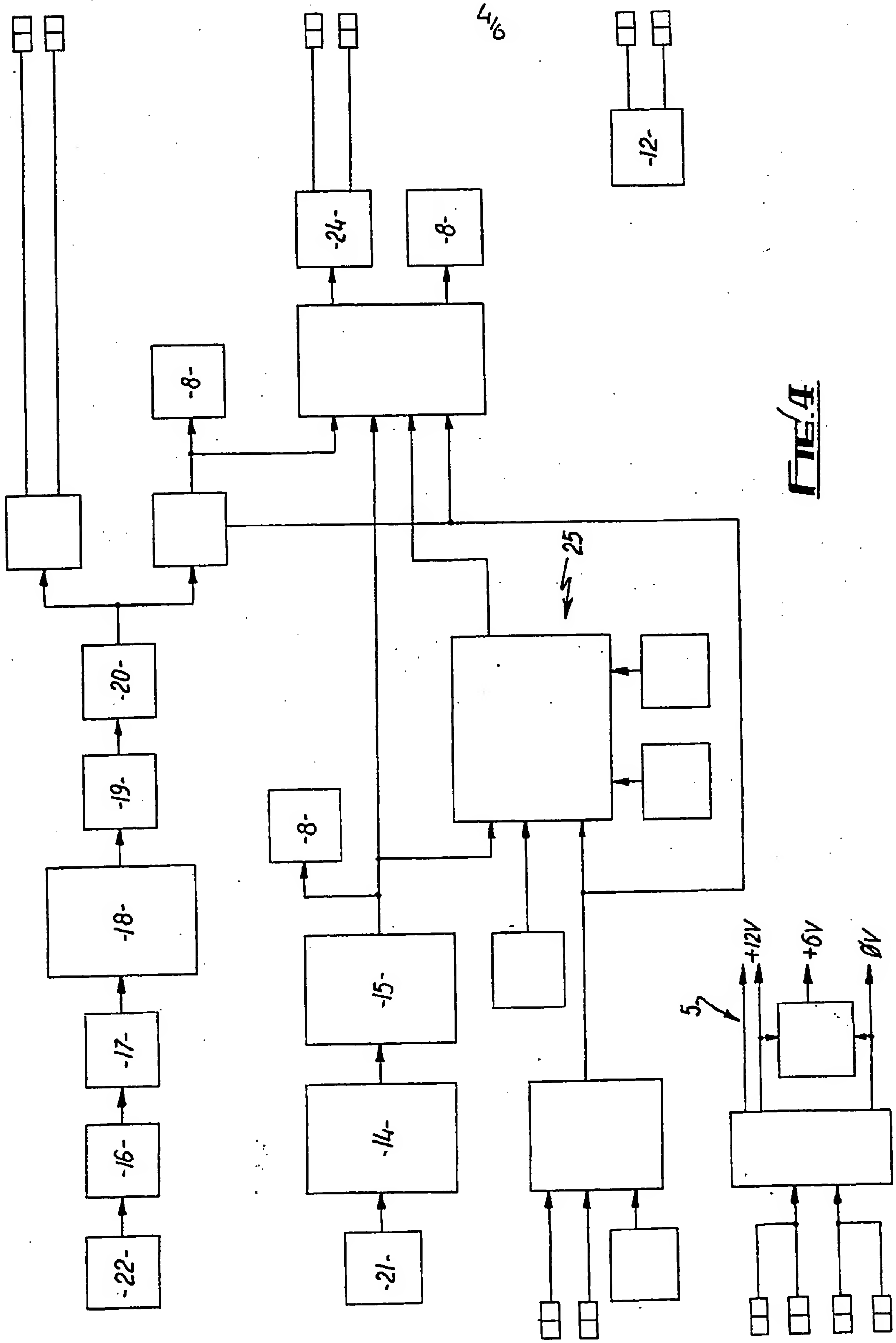

FIG.4

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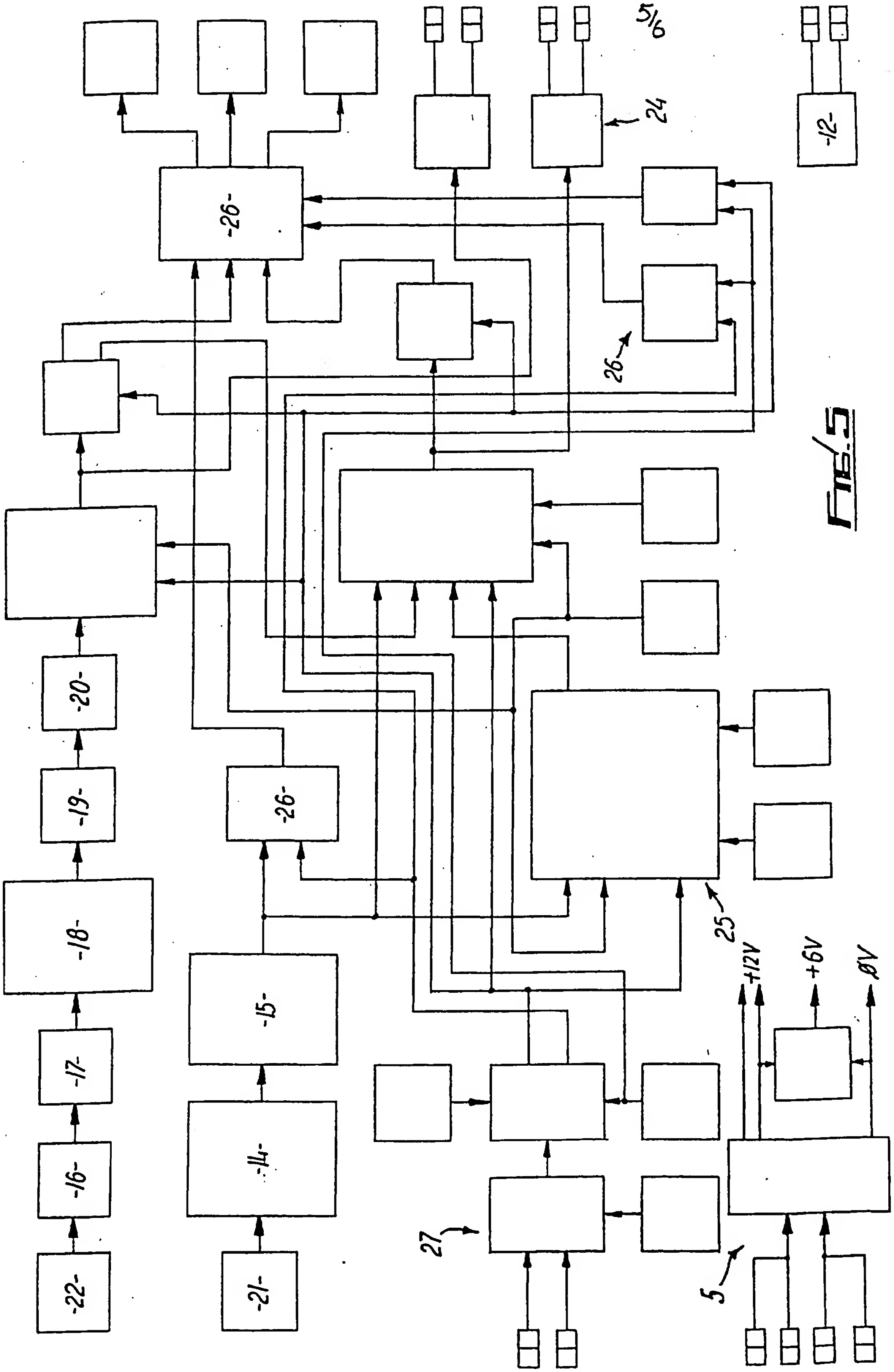

FIG. 5

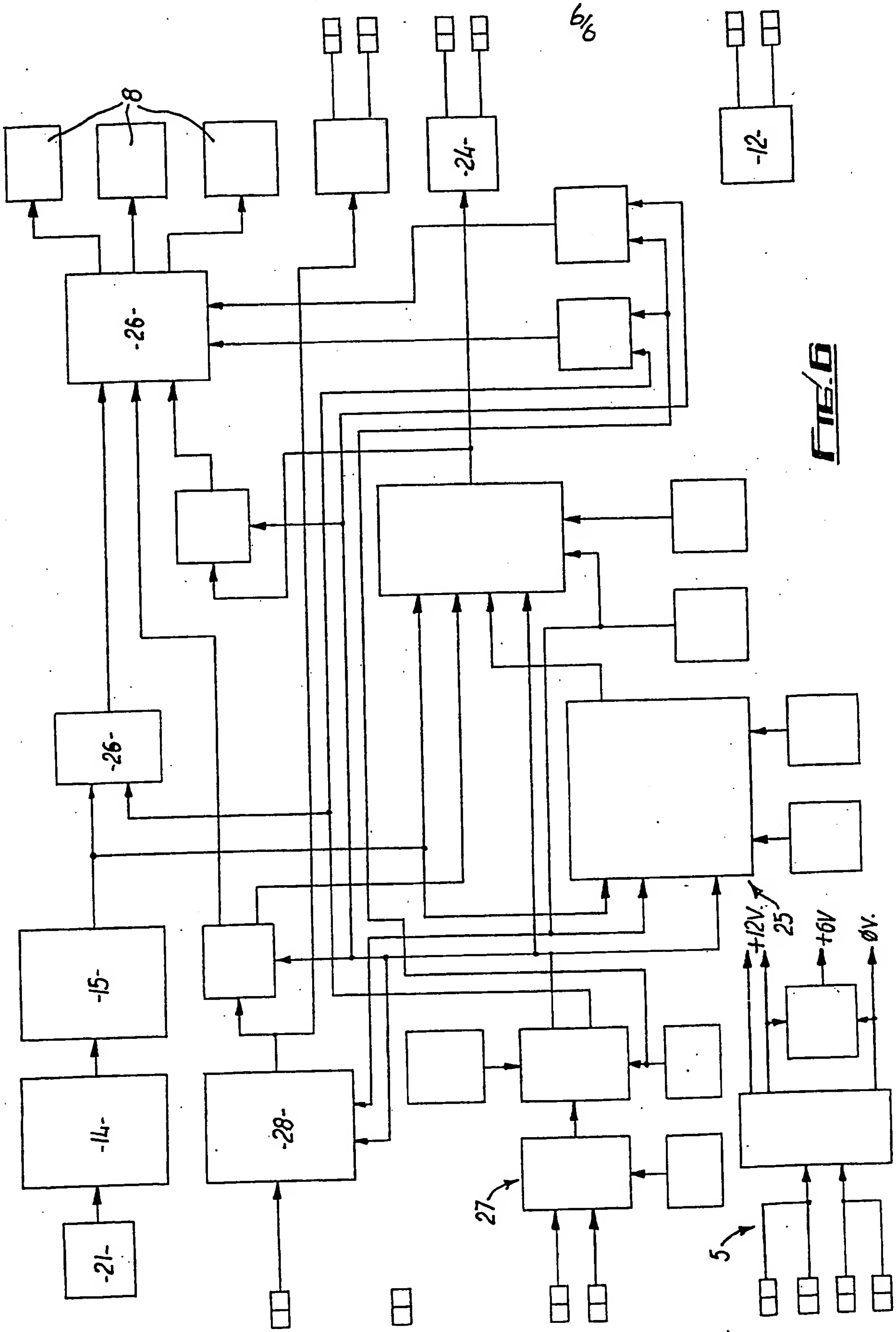

FIG. 6

SPECIFICATION

Alarm control system

This invention relates to an alarm control system for use in an intruder alarm system.

At present intruder alarms are frequently activated accidentally or by inconsequential events which are not related to the attempted, or successful, entry of an intruder into a building fitted with an alarm. The frequent activation of the alarm is not only inconvenient but also lessens the effectiveness of the alarm as people become used to hearing the spuriously activated alarm on frequent occasions.

According to the present invention there is provided an intruder alarm system comprising a sensor, a controller and an alarm device, the controller activating the alarm device on receiving a plurality of signals from the sensor which correspond to a pattern pre-determined as being consistent with the entry or presence of an intruder.

The sensor may be in the form of an infra-red, acoustic, proximity or inertia sensor.

Preferably, a plurality of sensors is provided, the controller monitoring the signals from each sensor and activating the alarm when the sequence, or pattern, of signals from the sensors corresponds to a predetermined sequence which is consistent with the entry or presence of an intruder.

Preferably also, an anti-tamper sensor is provided for detecting interference with the system, the controller activating the alarm when a signal is received from the anti-tamper circuit.

The sensor and the controller may be provided in a single unit having only one alarm control output. Alternatively, the controller may be centrally located and linked to a plurality of spaced sensors.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a circuit diagram of a controller of one embodiment of an alarm control system in accordance with the present invention;

Fig. 2 is a sensor for use with the controller of Fig. 1;

Fig. 3 is a block circuit diagram of a second embodiment of an alarm control system in accordance with the present invention;

Fig. 4 is a block circuit diagram of a further embodiment of an alarm control system in accordance with the present invention;

Fig. 5 is a block circuit diagram of a still further embodiment of an alarm control system in accordance with the present invention; and

Fig. 6 is a block circuit diagram of yet a further embodiment of an alarm control system in accordance with the present invention.

Referring to Figs. 1 and 2 of the drawings, basic construction and operation of an alarm control system in accordance with the present invention, for use in an intruder alarm system, will now be described. The system comprises an infra-red sensor circuit 1 including an infrared detecting element 10, and an acoustic sensor circuit including a microphone and resonating pipe 11, illustrated in Fig. 2. These circuits are linked to a control circuit 3, illustrated in Fig. 1, the control circuit 3 being programmed to activate an alarm when the signals from the sensors 1 and 2 correspond to a predetermined pattern which is consistent with the entry or presence of an intruder.

The control circuit 3 is contained with a steel housing, the housing also containing a buzzer 4, a mains power supply shown generally at 5, and a twelve volt rechargeable battery 6.

A sixteen button four by four membrane key-pad 7 and eight LED displays 8 are mounted on the face of the housing.

The infra-red sensor circuit 1 and the acoustic sensor circuit 2 are contained in a casing which is provided with an anti-tamper sensor circuit 12, the alarm being activated when the anti-tamper sensor circuit 12 is violated. The casing is located in a room which is also provided with a door/window opening sensor which is not illustrated but may be of any desired type. The arrangement of sensors provides comprehensive protection of the room, or "zone".

In this embodiment the system features two zones, each having acoustic, infra-red, anti-tamper and door/window opening sensors.

The system is also provided with additional alarm activating sensors, in this embodiment these being a personal attack sensor with anti-tamper sensor, a 24 hour sensor with antitamper sensor, entry/exit door sensor with anti-tamper sensor, an alarm bell anti-tamper sensor, and a control circuit housing anti-tamper sensor. These sensors are not illustrated but may again be of any desired type as appropriate. Altogether the sensors provide a total of sixteen inputs for the control circuit 3, these being listed below with reference to Fig. 1.

These inputs shown generally at 13 are divided into three groups: Zone 1, Zone 2 and Auxiliary inputs. These inputs are listed below:

Zone One	1)	Infra-red sensor input
	2)	Acoustic sensor input
	3)	Door/window opening sensor input
	4)	Anti-tamper sensor input
Zone Two	5)	Infra-red sensor input
	6)	Acoustic sensor input
	7)	Door/window opening sensor input
	8)	Anti-tamper sensor input
Auxiliary	9)	Personal attack sensor input
	10)	Personal attack anti-tamper input
	11)	24 hour sensor input
	12)	24 hour anti-tamper input
	13)	Entry/exit door sensor input
	14)	Entry/exit door anti-tamper sensor input
	15)	Alarm bell anti-tamper sensor input
and	16)	Control circuit housing anti-tamper sensor input.

In use, the system may operate in one of two modes. In the first or open mode the control circuit 3 monitors inputs 4), 8), 9), 10), 11), 12), 14), 15) and 16), the alarm bell being activated when any one of these inputs in violated. This may for example be the preferred mode of operation when the premises are occupied.

In the second or closed mode all of the inputs are monitored. In this mode the alarm is activated when the inputs sensed by the control circuit 3 coincide with a sequence or configuration of programmed inputs which the user has judged to be consistent with the entry or presence of an intruder.

The activating sequences and configurations of inputs chosen to operate the alarm in mode two are entered through the key-pad 7 by an engineer. The programmed configurations are protected by an individual four digit engineering password.

The user may switch the system between modes by means of an individual four digit user password.

An example of a sequence of inputs required to activate the alarm is listed below.

1. If an acoustic sensor input is violated by, for example, the sound of a breaking window, the control circuit enters a half-alarm state. If the infra-red sensor input in the same zone is then also violated by, for example, the presence of an intruder who has entered through the broken window, the alarm is activated.

2. If an infra-red sensor input is violated the control circuit enters the half-alarm state. If the same sensor input is subsequently violated at least four times in any one minute period, consistent with an intruder moving around or through a room, the alarm is activated.

3. If the entry/exit door sensor input is violated the alarm is activated after an entry time has elapsed if the user password has not been entered through the key-pad 7.

4. If any other sensor input, for example a tamper sensor, is violated the alarm is activated immediately.

By monitoring the inputs from both the infra-red and acoustic sensors in each zone and only activating the alarm, in predetermined circumstances the number of false alarms caused by the system is minimised.

Further details of apparatus forming various embodiments of the invention will now be de- [illegible] ay of example, with reference to Figs. 3—6 of the drawings. Details of power

supply circuits will also be described.

The power supply circuits are illustrated in general terms only. Further details will be described below.

In the interests of clarity, certain devices which are described but not illustrated have been allocated reference letters.

The mains power supply 5 is best illustrated in Fig. 1 and is connected to the control circuit 3 by means of a three-way terminal block which is bolted to an inside face of the steel housing. The block is provided with a fuse on the live connection and connects the housing to the mains earth through a steel mounting bolt. All other field connections from control circuit 3 are made through a terminal strip mounted on the circuit board.

The power supply to the integrated circuit (IC) circuitry of the control circuit 3 is separate from the power supply to the relays and LEDs 8 present in order to minimize the effect of power supply transients caused by the switching of the relays and LEDs 8 on the sensing circuits. A resistance capacitance (RC) low pass filter A having an aluminium electrolytic capacitor is used to smooth the power supply to the IC circuitry. The filter A, when loaded with the IC circuitry, gives a pole of a desired frequency and at this frequency the attenuation of the filter A increases at a known rate. As aluminium electrolytic capacitors have a significant series resistance at high frequencies, a ceramic disc capacitor is connected in parallel with the capacitor in the filter to improve attenuation at radio frequencies.

A tantalum bead capacitor is connected across the power supply to the relays and LEDs 8 to supress switching transients which could otherwise be coupled to the IC circuitry.

The IC circuitry, of operational amplifiers and comparators, requires a balanced bi-polar power supply. To provide this a single rail D.C. power supply is split after the RC low pass filter A by using integrated circuit (IC) B and two complementary transistors C and D.A reference voltage equal to half the single supply rail voltage is set up at the noninverting input of IC B. The output of IC B drives the two complimentary transistors C and D, both connected as emitter followers with the emitters driving the split supply rail. Unity negative feedback from the split supply rail to the inverting input of IC B closes the control loop and thus ensures that the split supply rail voltage will follow the reference voltage. A tantalum bead capacitor is connected across each half of the split supply to improve its transient response.

The infrared detecting sensor 1 used is specifically designed for use in low power passive infra-red movement detection applications. Within the sensor 1 are two differentially connected detection elements E and F which provide immunity from common mode signals such as those generated by variations in ambient temperature, background radiation and acoustic noise. The two detection elements E and F are combined within the sensor 1 using a single FET impedance converting amplifier G. An output signal is obtained only when radiation falling on the two detection elements E and F is unbalanced, as in a focused system. Infra-red radiation from the area being monitored is focused onto the sensor by means of plastic lens. A selection of lenses are available for different applications: for example, long range narrow angle; wide angle; and general purpose angle.

To minimize the effect of noise from the power supply rail on the signal output from the sensor 1, the sensor 1 given a separate power supply. This is formed by a zener diode, a tantalum bead capacitor, and a resistor. The signal output from the sensor 1 drives into a load H and the voltage developed across the load H is amplified by the noninverting amplifier formed by an IC J. The very high input resistance formed by IC J will have a negligible loading effect on the signal output of the sensor 1. The output from IC J is fed into an inverting amplifier formed by an IC K.

Two voltage comparators, IC L and IC M monitor the output of IC K and if the output of IC K becomes greater than a chosen voltage the open collector output of IC L turns on. If the output of IC K becomes less than a chosen voltage the open collector output of IC M turns on. As the open collector outputs of IC L and IC M share a common pull up resistor N, when either output turns on, the signal end of the pull up resistor N will be pulled to OV. Thus, if the output of IC K goes outside the range of the chosen voltage the signal end of the pull up resistor N is driven to OV. This signal is, in turn, fed via an RC network P to another inverting comparator formed by an IC R.

IC R is used to drive a relay which gives an open contact output (relay powered off) for an alarm condition. A reverse biased diode is connected across the relay coil to suppress reverse voltage transients when the coil is deenergised. The output of IC M is also used to drive an NPN transistor connected as an emitter follower. The transistor in turn drives a red LED which indicates an alarm condition when on.

The inverting comparator formed by IC R has positive feedback applied to it such that it has a low input voltage switching hysteresis. This hysteresis helps to prevent spurious switching of the output of the comparator caused by stray coupling between the output and the inverting input.

Positive feedback is also applied from the output of IC R to the inputs of the first two

comparators, formed by IC R and IC M. This feedback helps prevent spurious switching of the first two comparators caused by stray coupling between their non-inverting inputs and the output of the IC R.

The RC network S fitted between the first two comparators IC L and IC R, and the final comparator IC R, serves two purposes. When combined with the pull up resistor N it results in a circuit which allows the capacitor in the RC network S to charge up slowly through resistor H and resistor N when both of the first two comparators' outputs are off, yet allows the capacitor in the RC network S to discharge quickly through the resistor H only when either of the first two comparators' outputs turn on (the alarm condition) and with the effect that when an alarm condition is detected the relay will be turned off for a mininum time period of 200 ms, long enough for the relay and the control circuit 3 to respond. If the capacitor M in the RC network S was omitted this minimum time period would drop to zero and, in addition, a delay occurs between the output of either of the first two comparators changing due to the presence of the resistor H, the change being detected by the final comparator. This delay greatly reduces the effect of stray coupling between the output of IC R and the infra-red detection circuitry.

All the measures taken to reduce the effect of stray coupling between the output of IC R and the rest of the infra-red detecting circuit result in clean, dither free switching of the relay and LED when human movement is detected.

In the acoustic sensor 2 an electret condenser microphone is used to listen for the sound of breaking glass. The response of the microphone is tuned to the sound of breaking glass by fitting a tuning pipe, the length of the tuning pipe being equal to quarter the wave-length of the average sound pressure wave radiated from breaking glass.

The output signal from the microphone is filtered by means of a RC high pass filter.

A portion of the resistance in the RC high pass filter is made up by a preset potentiometer. The level of signal tapped off from the potentiometer is utilised by the remainder of the acoustic sensor circuit, such that adjusting the potientiometer alters the sensitivity of the sensor 2. The range over which the sensor 2 can detect the sound of breaking glass is compatible with the range over which the Infrared Detector can detect human movement.

The signal from the preset potentiometer is amplified using a non-inverting amplifier formed by an IC T. The very high input resistance of this non-inverting amplifier has a negligible loading effect on the RC high pass filter.

The output from IC T is fed into two active resonant bandpass filters in series. The first filter is formed by an IC U and the second filter is formed by an IC V.

After the very narrow band-pass filtering and amplification by the filters IC U and IC V the resulting signal is rectified using a diode and then filtered using a low pass RC filter W. The capacitor of the filter W is allowed to discharge through a bleed resistor. The voltage level appearing at the negative end of the capacitor of the filter W is monitored by an inverting comparator formed by an IC X. This comparator has positive feedback applied to it such that it has an input voltage switching hysteresis. The hysteresis helps to prevent spurious switching of the comparator's output caused by stray coupling between its output and its inverting input.

The voltage appearing at the negative end of the capacitor in the filter W falls on picking up the sound of breaking glass. If the voltage falls below a chosen voltage the output of IC X switches from low to high. When the output of IC X is low it drives a relay, the relay giving an open contact output for an alarm condition. A reverse biased diode is connected across the relay coil to suppress reverse voltage transients when the coil is de-energised. The output from IC X also drives a thyristor via an NPN transistor connected as an emitter follower. The thyristor controls current through a red LED. When power is first applied to the sensors 1 and 2 the relay will energize and the thyristor and thus the LED is off. If breaking glass is detected the thyristor turns on as the relay de-energises. Once turned on, the thyristor stays on until it is reset by interrupting the power supply to the sensors 1 and 2. To ensure that the thyristor is not turned on by stray coupling a resistor and a capacitor are connected between its gate and cathode. The bias current required to turn the thyristor on is limited by a resistor.

The tamper detection circuit for the sensor unit is made using a micro-switch fitted with a leaf actuator mounted on the circuit board in the unit. When the casing is secure the tamper contacts are made though if the casing is removed the Tamper contacts open.

Now referring to Fig. 3 of the drawings, a general block diagram of an alarm control system, for use in an intruder alarm system and incorporating the detailed circuitry described above is illustrated. The system comprises an infra-red sensor 21 in the form of an infra-red detecting element and lens assembly, and an acoustic sensor 22 in the form of a microphone and resonating pipe. The infra red sensor 21 is connected through bandpass amplifier circuitry 14 and comparator circuitry 15 to a control circuit in the form of a micro-controller integrated circuit 23. The acoustic sensor 22 is also connected to the control circuit through a high pass filter and sensitivity adjustment circuit 16, amplifier 17, active resonant bandpass amplifier 18, rectifier and low pass filter circuits 19 and comparator circuits 20. The control circuit 23 is programmed

from the sensors 21 and 22 correspond to a predetermined pattern which is consistent with the entry or presence of an intruder. Various warning LEDS 8 and a tamper device 12 are also illustrated.

The system is contained with a wall mounted housing. The infra-red sensor 21 is tuned to detect human movement and the acoustic sensor 22 is tuned to detect the sound of breaking glass.

While the system is operating the sensors are continually monitored. If the acoustic sensor 22 detects the sound of breaking glass and the sensor circuit is tripped and the infra-red sensor 21 subsequently detects a presence or movement, the sensor circuit is tripped and the control circuit 23 activates the alarm. The alarm circuit is also activated when the infra-red sensor circuit is tripped four or more times in any one minute period.

As with the first embodiment described above, the monitoring of both sensor circuits minimises the occurrence of false alarms.

Figures 4, 5 and 6 illustrate further embodiments and like components are accorded corresponding reference numerals.

The embodiment of Fig. 4 is similar to that of Fig. 3 but further includes details of timer circuitry 25 associated with the infra-red sensor 21 which has the function of tripping the alarm circuitry when the infra-red circuitry is tripped a pre-determined number of times in a set period.

The embodiment of Fig.5 is again similar but further includes various memory circuitry 26 and reset circuitry 27.

A further embodiment is illustrated in Fig. 6 which includes an auxiliary circuit input 28 in addition to the infra-red sensor 21.

Modifications and improvements may be incorporated without departing from the scope of the invention.

CLAIMS

1. An intruder alarm system comprising a sensor, a controller and an alarm device, the controller activating the alarm device on receiving a plurality of signals from the sensor which correspond to a pattern pre-determined as being consistent with the entry or presence of an intruder.

2. An intruder alarm as claimed in Claim 1, wherein the sensor is selected from the group consisting of infra-red, acoustic, proximity and inertia sensors.

3. An intruder alarm as claimed in Claim 1 or 2, wherein a plurality of sensors are provided, the controller monitoring the signals from each sensor and activating the alarm on receiving a sequence or pattern of signals from the sensors corresponding to a sequence pre-determined as being consistent with the entry or presence of an intruder.

4. An intruder alarm as claimed in any one of the preceding claims including an anti-tamper sensor, the controller activating the alarm on receiving a signal from the antitamper sensor.

5. An intruder alarm system substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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